1-Hour SO_2 Nonattainment SIP Modeling

2014 EPA Regional/State/Local Modelers' Workshop
Salt Lake City, UT

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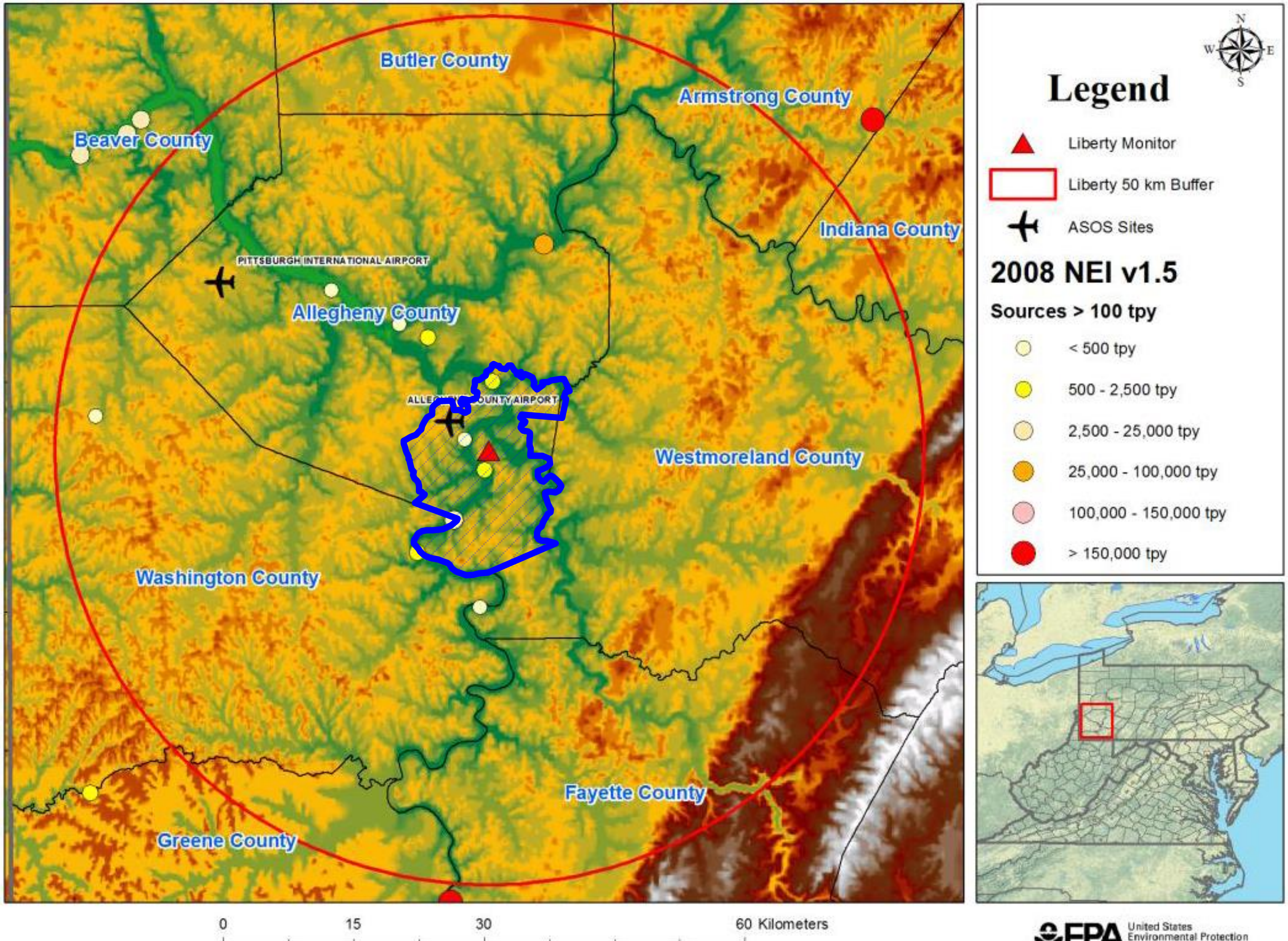
Models Used for Allegheny County SIPs

- PM_{10} SIP – 1994: IGM (combination of ISC, BLP, CTDM)
- SO_2 Redesignation – 2001: AERMOD
- $PM_{2.5}$ SIP (1997 NAAQS) – 2010: CMAQ w/CALPUFF
  - With CALPUFF for local impacts
  - SIP now withdrawn, clean data determination
- $PM_{2.5}$ SIP (2006 NAAQS) – 2013: CAMx w/PiG
  - CAMx with AERMOD for local also tested, PiG performed adequately
- SO_2 SIP (2010 NAAQS) – 2014: AERMOD
  - Local workgroups held since Aug. 2013

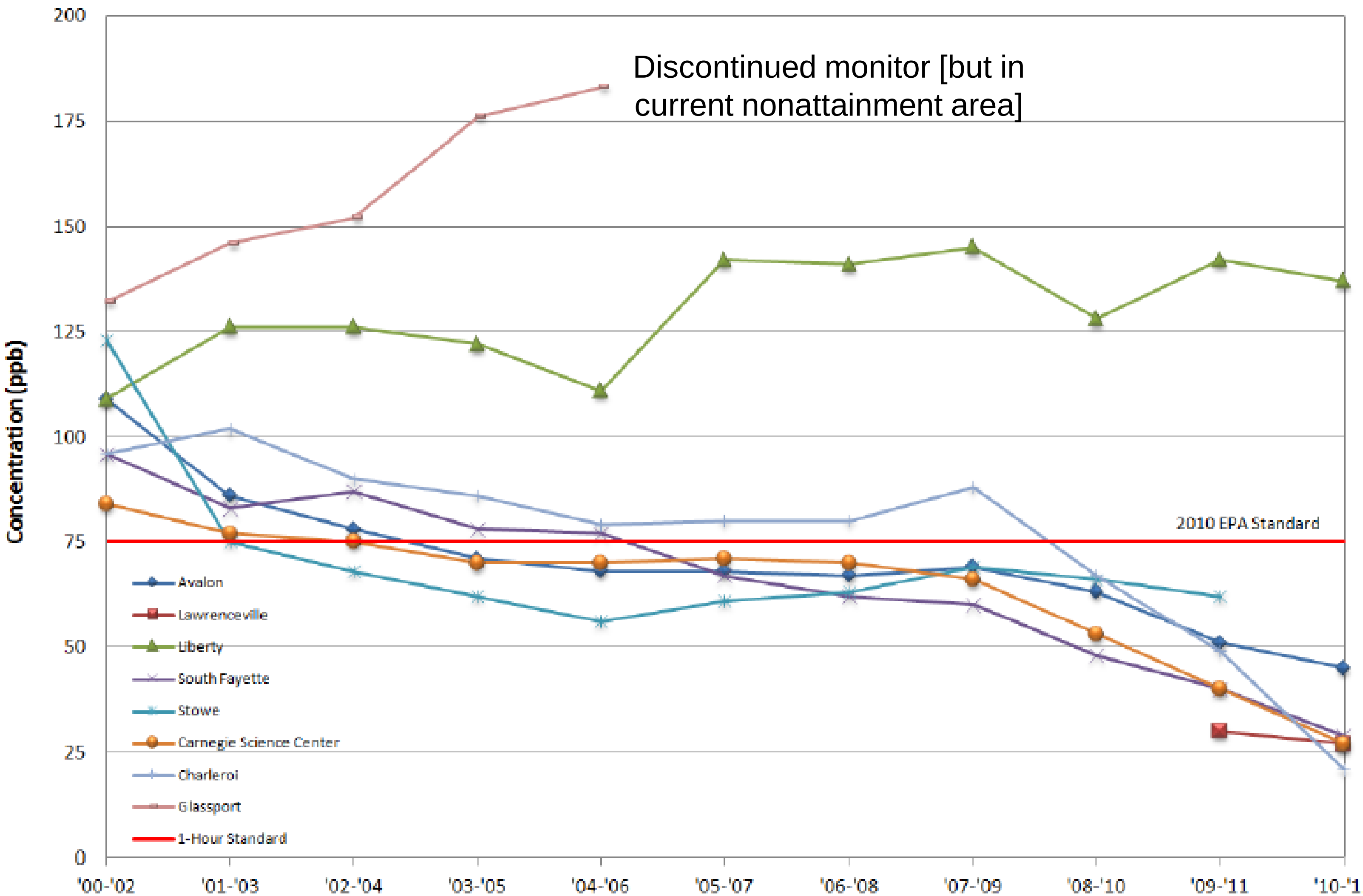
Allegheny, PA SO_2 Nonattainment Area



EPA United States Environmental Protection Agency

View from Downwind Hillside

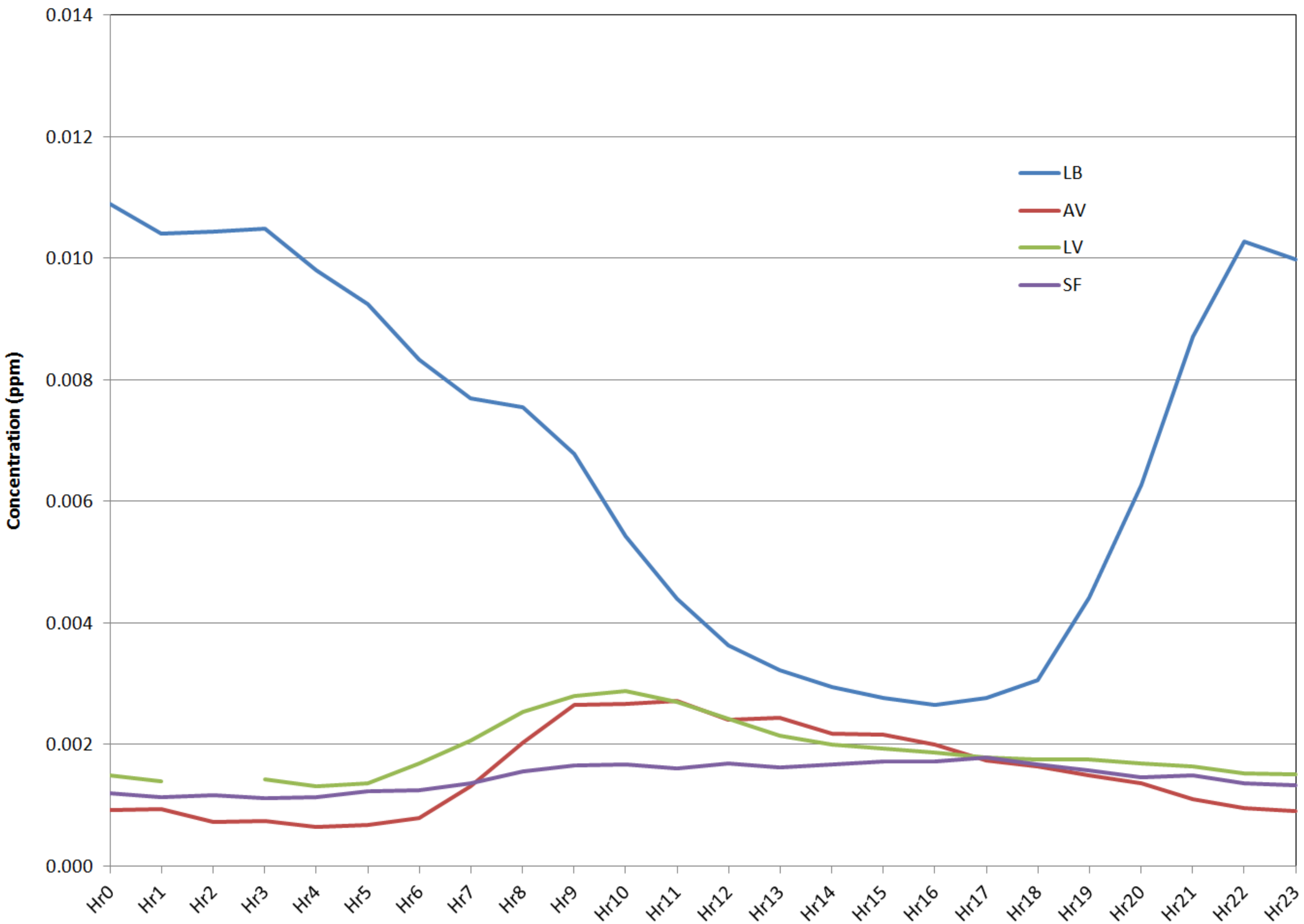
SO_2 1-Hr Design Values, 2000-2012



Nonattainment Monitor

Background Monitors

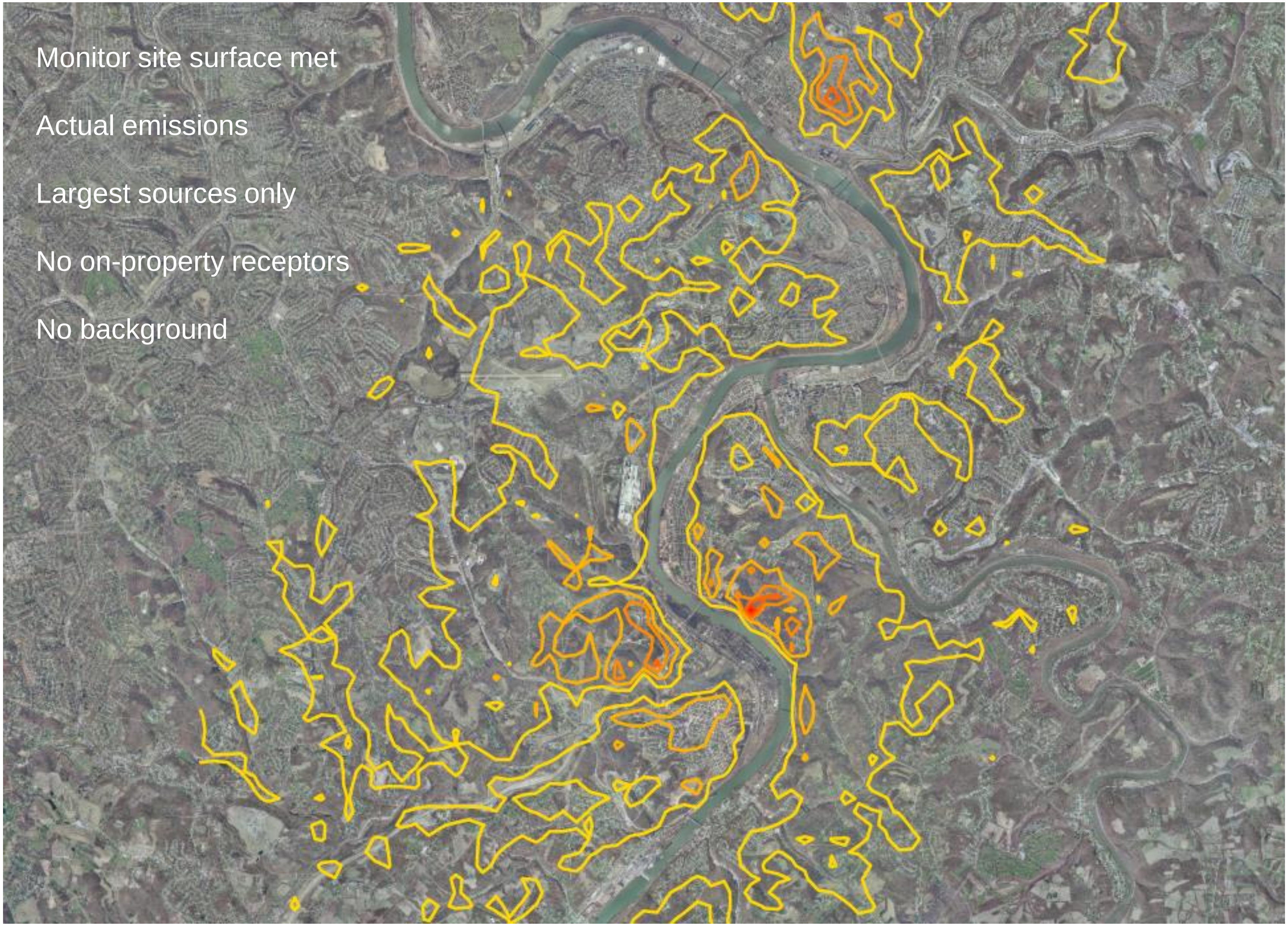
2012 SO_2 Hourly Averages



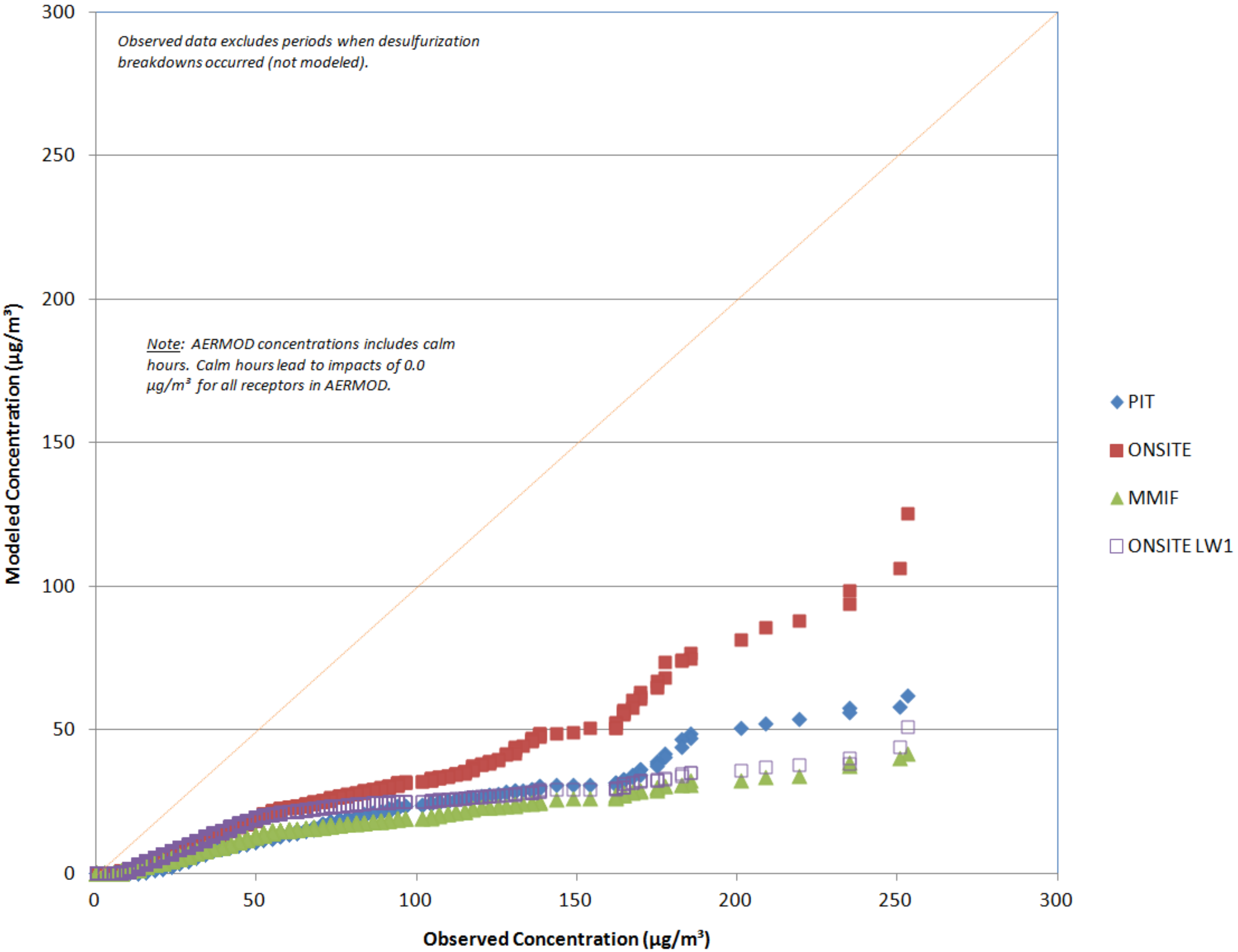
Nonattainment Monitor

Background Monitors

Typical AERMOD Contours, Default Mode



Typical Hourly Q-Q Plot for Nonattainment Monitor



AERMOD Performance

- Overestimating in many areas, underestimating at nonattainment monitor
- Based on conceptual model, previous studies
  - Max impacts should be primary/secondary hillsides
  - Inversions are key to met profiles – airport UA good enough?
  - Valley wind flow present
- Different met data tested
  - Airport, onsite, MMIF, U*, SODAR (ongoing)
  - Met sensitivity
- Options tested
  - Urban mode sensitivity
  - LowWind sensitivity

AERMOD 4th-High Daily Max, Different Scenarios

AERMOD Scenario, 2011 Test Year	Nonattainment Monitor	Max in NAA
PIT Airport met, default	366	693
Onsite met, default	149	517
MMIF met, default	162	517
Onsite met with Adj U*, LowWind	39	230
Onsite Met, Urban Mode, 100 Population	319	1318
Onsite met, Urban Mode, 5000 Population	204	439
Onsite Met, Urban Mode, 400 Population, MMIF	208	547
Onsite Met, Urban Mode, 400 Population, Adj U*, LowWind	195	407

4th-high daily max w/o breakdown periods = 208 µg/m^3

NAAQS = 196 µg/m^3

Alternative Model 4th-High Daily Max's

Model Scenario, 2011 Test Year	Nonattainment Monitor	Max in NAA
CALPUFF, MMIF met, 12 km	354	1006
CALPUFF, CALMET met, 4 km	64	600
CALPUFF, WRF met 12 km, 100 m computational grid	101	961

Model Scenario, 2007 Test Year	Nonattainment Monitor	Max in NAA
CAMx, WRF 12/4/0.8 km, PiG for local sources	97	--
- But best in time/space and low conc hours		

Model Scenario	Nonattainment Monitor	Max in NAA
SCICHEM, MMIF met, No Chemistry	?	?

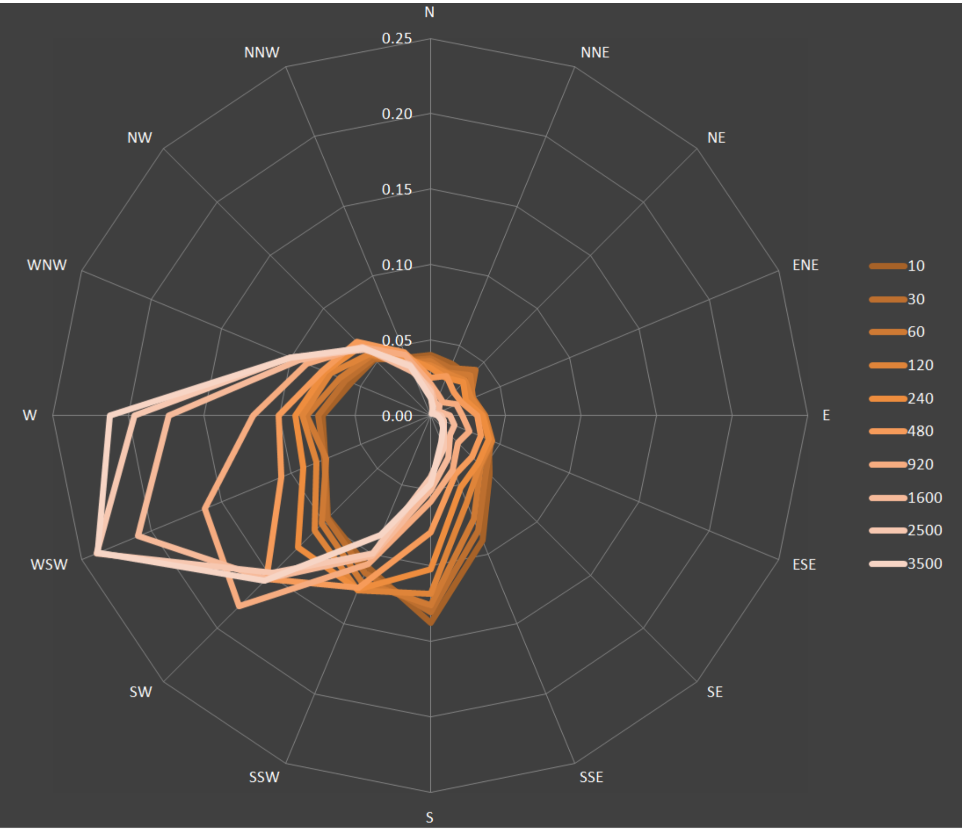
2011 4th-high daily max w/o breakdown periods = 208 µg/m^3

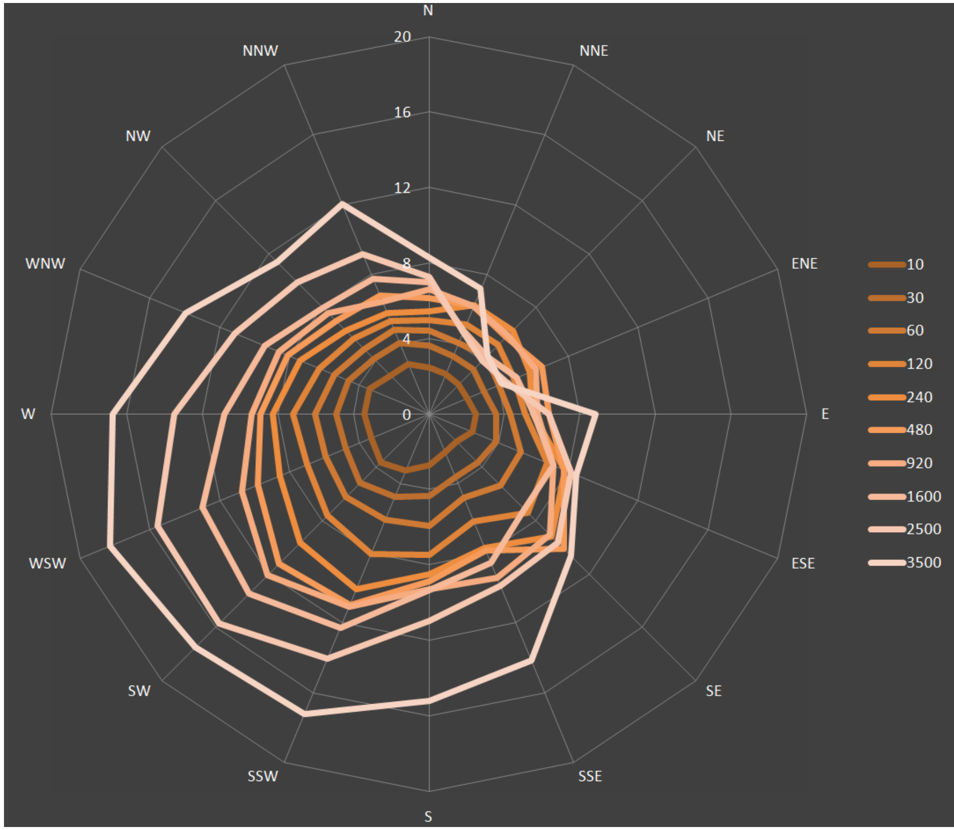
NAAQS = 196 µg/m^3

Model Issues

- Appropriate meteorology
  - Typical airport/onsite may be missing valley-specific conditions
- Source characterization
  - Buoyant lines sources
  - Intermittent flares
- Downwash apparent for some mid-size stacks
- Plume rise may be too low overall, but sensitive to options
  - May need to enhance rise, but then cap emissions in the valley
- AERMOD “straight-line” dispersion with critical hill heights

MMIF Stacked Radar Plots, 1-Point AERMOD, 2011



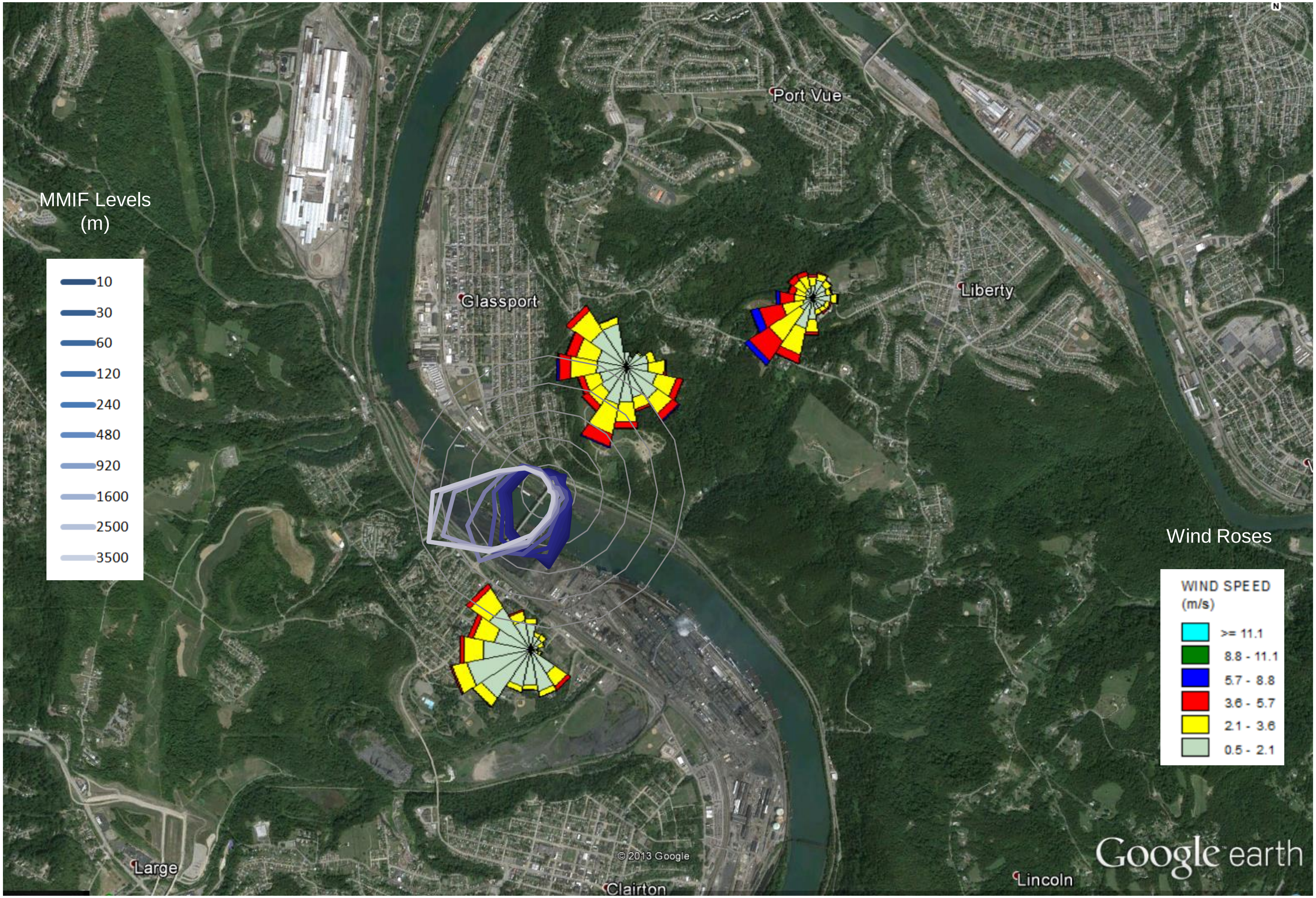


Wind Direction Frequencies

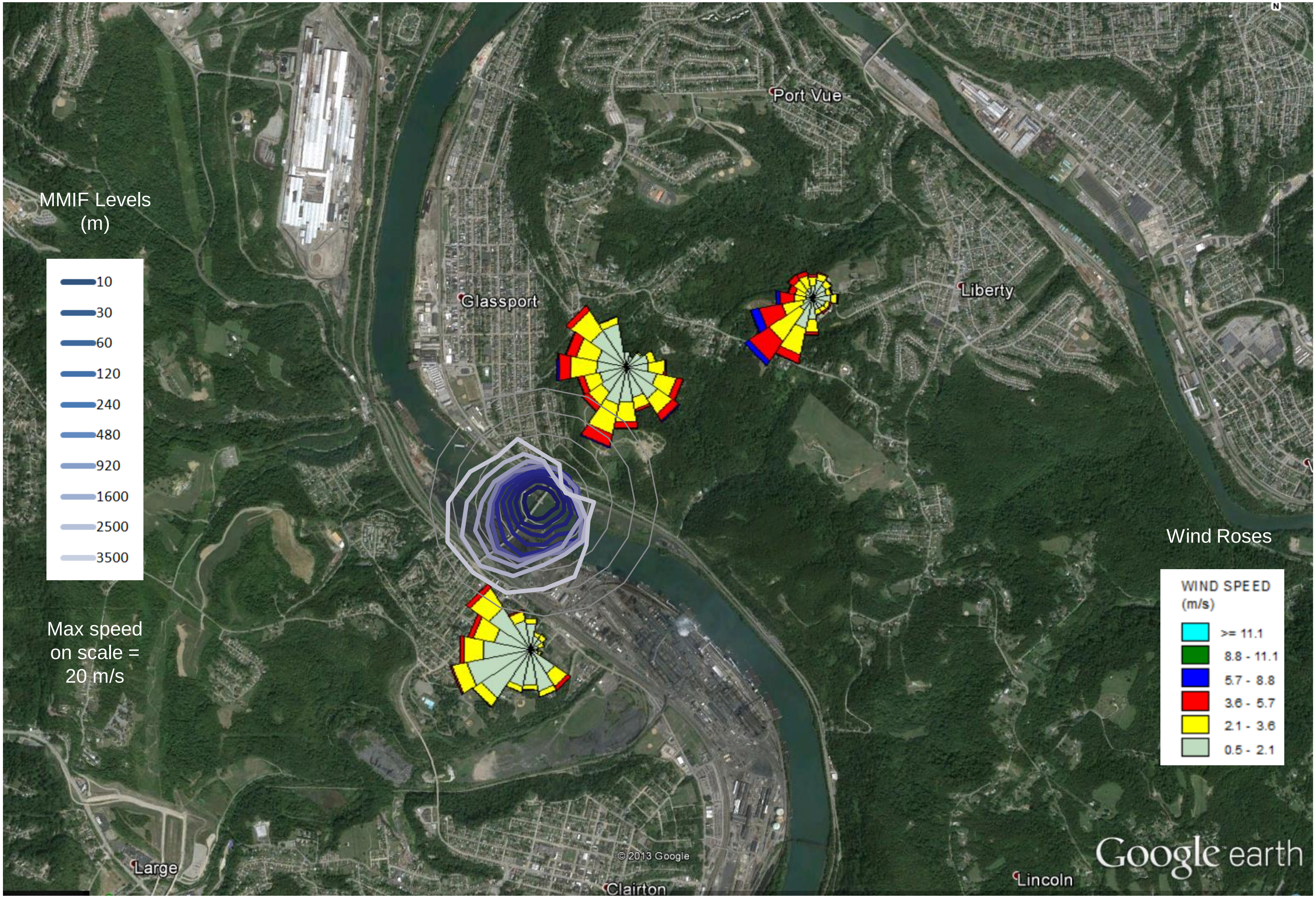
- Levels in meters -

Wind Speeds

Historical Met w/MMIF Frequency Overlay

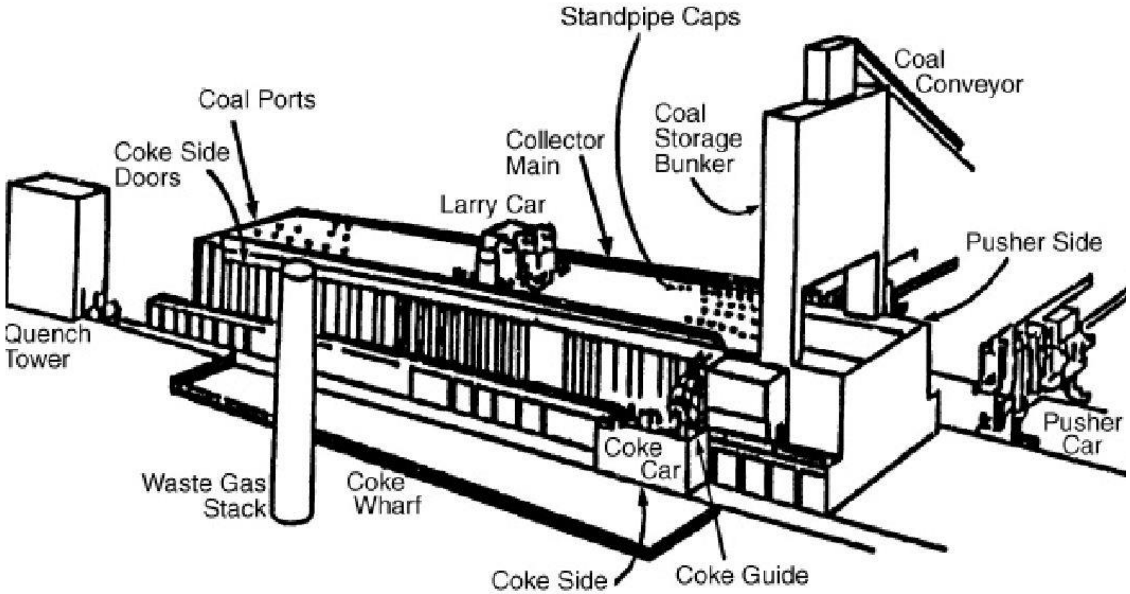


Historical Met w/MMIF Speed Overlay



Historical Pollution Roses

Buoyant Line Sources, BLP



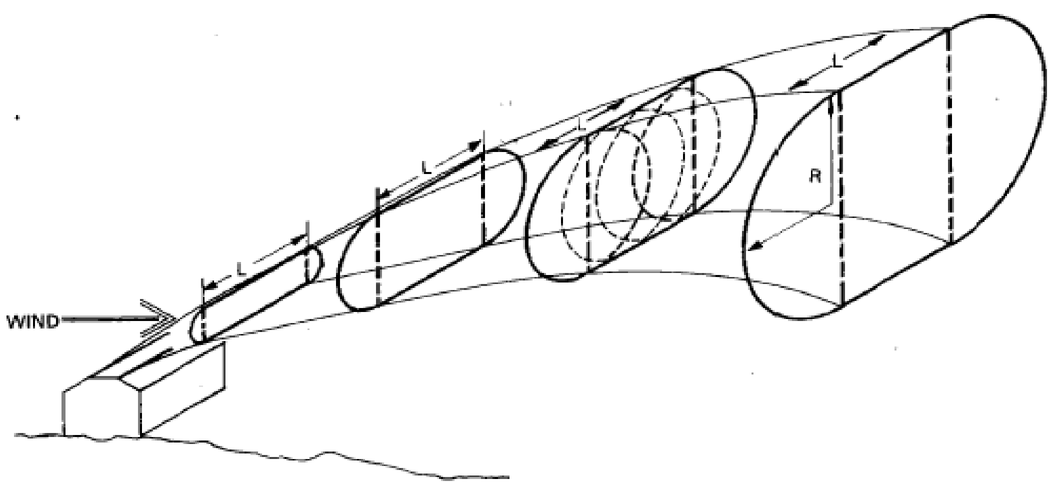
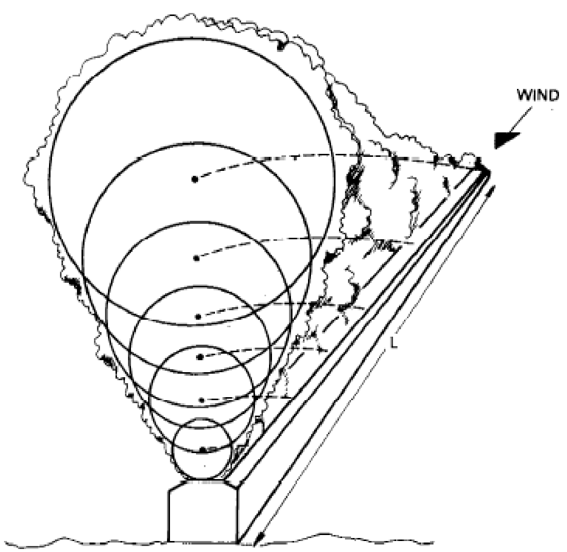


Figure 2-7 Rectangular (Line Source) Plume Rise Half-Circular (Entrained) Edges



igure 2-9 Cross Section of Line Source at X = X_{FB} with Parallel Winds

Buoyant Line Handling in AERMOD

- F’ buoyancy parameter dependent on size and temp of line

$$F' = \frac{g\ L\ W_M\ w\ (T_s - T_a)}{T_s}$$

- Input directly into BLP
  - BLP: flat-terrain, outdated met formats and P-G stability

- Or, BLP can be modified to generate plume rise by hour
  - Volume sources in AERMOD with hourly variable dimensions

- Plume rises can also be calculated outside BLP
  - Or visually, by camera, etc.

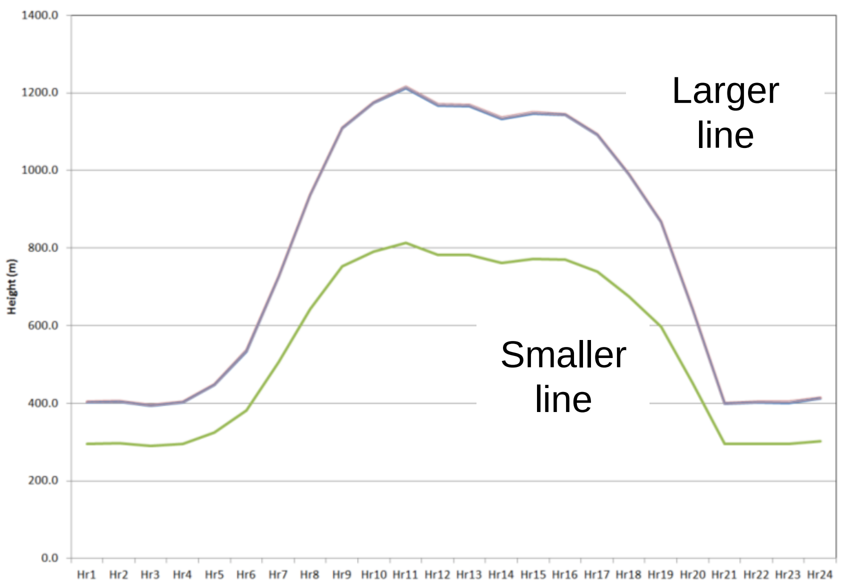
- For any case in AERMOD, buoyant line algorithms are not utilized

BLP to Generate Plume Rise

PLUME RISE HEIGHTS AND DISTANCES OUTPUT

YR	JDAY	HR	DH1	DH2	DH3	DH4	DH5	DH6	DH7	XF1	XF2	XF3	XF4	XF5	XF6	XF7
1991	1	1	0.00	143.39	153.58	163.76	173.87	183.90	193.84	0.00	132.47	139.96	147.46	154.96	162.45	169.95
1991	1	2	0.00	Inf	Inf	Inf	Inf	Inf	Inf	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1991	1	3	0.00	134.97	145.86	156.72	167.52	178.22	188.81	0.00	127.96	135.95	143.93	151.92	159.91	167.89
1991	1	4	0.00	118.69	131.38	144.05	156.61	169.02	181.27	0.00	117.62	126.84	136.06	145.29	154.51	163.73
1991	1	5	0.00	53.43	76.17	98.90	121.03	142.46	163.19	0.00	64.17	79.49	94.82	110.15	125.47	140.80
1991	1	6	0.00	109.22	123.06	136.86	150.54	164.03	177.31	0.00	110.80	120.78	130.75	140.72	150.70	160.67
1991	1	7	0.00	133.66	144.56	155.43	166.24	176.95	187.55	0.00	127.10	135.08	143.06	151.04	159.02	167.00
1991	1	8	0.00	111.15	124.79	138.40	151.89	165.19	178.30	0.00	112.27	122.13	131.98	141.84	151.69	161.55
1991	1	9	0.00	6.53	46.75	88.64	127.56	163.90	198.15	0.00	18.18	47.88	77.58	107.28	136.98	166.68
1991	1	10	0.00	67.38	398.05	636.87	840.23	1022.83	1191.20	0.00	122.75	631.18	1139.62	1648.05	2156.49	2664.92
1991	1	11	0.00	12.33	426.38	715.92	960.95	1180.40	1382.45	0.00	34.93	543.36	1051.80	1560.23	2068.66	2577.10
1991	1	12	0.00	45.08	552.03	903.89	1201.82	1468.73	1714.53	0.00	62.29	570.72	1079.16	1587.59	2096.03	2604.46
1991	1	13	0.00	137.77	624.87	972.77	1268.64	1534.20	1779.00	0.00	133.94	642.37	1150.80	1659.24	2167.67	2676.11
1991	1	14	0.00	177.51	666.02	1014.00	1309.88	1575.43	1820.23	0.00	139.70	648.13	1156.57	1665.00	2173.44	2681.87
1991	1	15	0.00	39.98	388.61	638.92	851.76	1042.75	1218.79	0.00	86.67	595.10	1103.54	1611.97	2120.40	2628.84
1991	1	16	0.00	0.58	284.63	495.66	674.70	835.19	983.01	0.00	10.91	519.34	1027.78	1536.21	2044.65	2553.08
1991	1	17	0.00	32.71	272.13	448.96	599.95	735.68	860.90	0.00	109.30	617.73	1126.17	1634.60	2143.04	2651.47

Diurnal Pattern



Methodology to Date

- AERMOD with best-case options
  - Iterative, but need justification for options/characterizations
  - Awaiting bids for contractor assistance
  - Control strategy
- If modeled attainment can't be shown throughout area
  - Control strategy for nonattainment monitor only
    - Use a representative nearby area, similar to $PM_{2.5}$
    - Deploy additional monitors, similar to designations (round 2)
  - Other options?
- Beyond guidance
  - Should modeling be used relatively, similar to $PM_{2.5}$?
  - Use "derived" met data set?
    - Based on historical, MMIF, SODAR, valley flow, etc.

Questions? Recommendations? Help?